Chapter 2

Section 2.1

Check Your Understanding, page 89:

1. c
2. Her daughter weighs more than 87% of girls her age and she is taller than 67% of girls her age.
3. About 65% of calls lasted less than 30 minutes. This means that about 35% of calls lasted 30 minutes or longer.
4. The first quartile (25th percentile) is at about Q_1 = 13 minutes. The third quartile (75th percentile) is at about Q_3 = 32 minutes. This suggests that the $IQR = 32 - 13 = 19$ minutes.

Check Your Understanding, page 91:

1. $z = \dfrac{65-67}{4.29} = -0.466$. Lynette's height is 0.466 standard deviations below the mean height of the class.
2. Brent's z-score is $z = \dfrac{74-67}{4.29} = 1.63$. Brent's height is 1.63 standard deviations above the mean height of the class.
3. Because Brent's z-score is -0.85, we know that $-0.85 = \dfrac{74-76}{\sigma}$. Solving for σ we find that $\sigma = 2.35$ inches.

Check Your Understanding, page 97:

1. Converting the heights from inches to centimeters will not change the shape. However, it will multiply the center (mean, median) and spread (range, *IQR*, standard deviation) by 2.54.
2. Adding 6 inches to each of the students' heights will not change the shape of the distribution, nor will it change the spread. It will, however, add 6 inches to the center (mean, median).
3. Converting the class heights to z-scores will not change the shape of the distribution. It will change the mean to 0 and the standard deviation to 1.

Exercises, page 99:

2.1 (a) Putting the data in order we get: 13, 13, 13, 15, 19, 22, 23, 23, 24, 26, 26, 30, 31, 34, 38, 49, 50, 50, 51, 57. The girl with 22 pairs of shoes has more shoes than 5 of the girls. Therefore, her percentile is $\dfrac{5}{20} = 0.25$. *Interpretation*: 25% of the girls had fewer pairs of shoes than she did.

(b) Putting the data in order we get: 4, 5, 5, 5, 6, 7, 7, 7, 7, 8, 10, 10, 10, 10, 11, 12, 14, 22, 35, 38. The boy with 22 pairs has more shoes than 17 of the boys. Therefore, his percentile is $\dfrac{17}{20} = 0.85$. *Interpretation*: 85% of the boys had fewer pairs of shoes than he did.

(c) The boy is more unusual because only 15% of the boys have as many or more than he has. The girl has a value that is closer to the center of the distribution with 25% having fewer shoes and 75% having as many or more.

2.2 (a) Because 4 states have smaller values for the percent of residents aged 65 and older, the percentile for Colorado is $\frac{4}{50} = 0.08$. *Interpretation*: 8% of states have a smaller percent of residents aged 65 and older.
(b) Because 40 states have smaller values for the percent of residents aged 65 and older, the percentile for Rhode Island is $\frac{40}{50} = 0.80$. *Interpretation*: 80% of states have a smaller percent of residents aged 65 and older.
(c) Colorado is the more unusual state having only 8% of the states with smaller percentages of residents aged 65 and older. Rhode Island has a value that is closer to the center of the distribution with 80% lower and 20% as large or larger.

2.3 A percentile only describes the relative location of a value in a distribution. Scoring at the 60^{th} percentile means that Josh's score is better than 60% of the students taking this test. If the test was relatively easy, it is possible that he got more than 60% of the questions correct. Likewise, if the test was difficult, it is possible that he got less than 60% of the questions correct.

2.4 Larry's wife should gently break the news that being in the 90^{th} percentile is not good news in this situation because lower blood pressure is better. About 90% of men similar to Larry have lower blood pressures. The doctor was suggesting that Larry take action to lower his blood pressure.

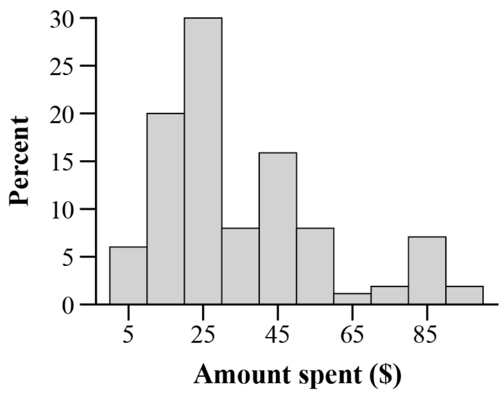
2.5 The girl in question weighs more than 48% of girls her age, but is taller than 78% of the girls her age. Because she is taller than 78% of girls, but only weighs more than 48% of girls, she is probably fairly thin.

2.6 Peter's time was slower than 80% of his previous race times that season, but it was slower than only 50% of the racers at the league championship meet. Because this time was relatively slow for Peter but at the median for the runners in the league championship, Peter must be a good runner.

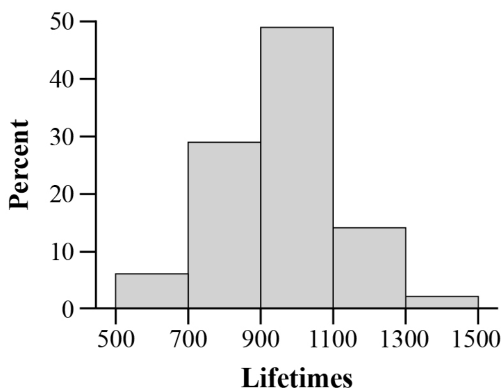
2.7 (a) The highlighted student sent about 205 text messages in the 2-day period, which placed her at about the 78^{th} percentile. This means that the student sent more texts than about 78% of the students in the sample.
(b) The median number of texts is the same as the 50^{th} percentile. Locate 50% on the y-axis, read over to the points, and then find the relevant place on the x-axis. The median is approximately 115 text messages.

2.8 (a) Maryland has about 12% foreign-born residents placing it at about the 72^{th} percentile. This means that about 72% of states have a smaller percent of foreign-born residents than Maryland.
(b) Locate 30% on the y-axis, read over to the points, and then find the relevant place on the x-axis. The 30^{th} percentile is approximately 4.5% foreign-born.

2.9 (a) First find the quartiles. The first quartile is the 25th percentile. Find 25 on the y-axis, read over to the line and then down to the x-axis to get about Q_1 = \$19. The 3rd quartile is the 75th percentile. Find 75 on the *y*-axis, read over to the line and then down to the *x*-axis to get about Q_3 = \$46. So the interquartile range is $IQR =$ \$46 – \$19 = \$27.
(b) The person who spent \$19.50 is just above what we have called the 25th percentile. It appears that \$19.50 is at about the 26th percentile.
(c) The graph is below:



2.10 (a) To find the 60th percentile, find 60 on the *y*-axis, read over to the line and then read down to the *x*-axis to find approximately 1000 hours.
(b) To find the percentile for the lamp that lasted 900 hours, find 900 on the *x*-axis, read up to the line and across to the *y*-axis to find that it is approximately the 35th percentile.
(c) The graph is below:



2.11 Eleanor's standardized score, $z = \dfrac{680-500}{100} = 1.8$ is higher than Gerald's standardized score, $z = \dfrac{27-18}{6} = 1.5$.

2.12 The standardized batting averages (z-scores) for these three outstanding hitters are:

Player	z-score
Cobb	$z = \frac{0.420 - 0.266}{0.0371} = 4.15$
Williams	$z = \frac{0.406 - 0.267}{0.0326} = 4.26$
Brett	$z = \frac{0.390 - 0.261}{0.0317} = 4.07$

All three hitters were at least 4 standard deviations above their peers, but Williams' z-score is the highest.

2.13 (a) The fact that your standardized score is negative indicates that your bone density is below the average for your peer group. Furthermore, your bone density is about 1.5 times farther below average than a typical below-average density.
(b) If we let σ denote the standard deviation of the bone density in Judy's reference population, then we can solve for σ in the equation $-1.45 = \frac{948 - 956}{\sigma}$. Thus, $\sigma = 5.52$ g/cm^2.

2.14 (a) Mary's z-score (0.5) indicates that her bone density score is about half a standard deviation above the average score for all women her age. Because her z-score is higher than Judy's ($z = -1.45$), Mary's bones are healthier when comparisons are made to other women in their age groups.
(b) If we let σ denote the standard deviation of the bone density in Mary's reference population, then we can solve for σ in the equation $0.5 = \frac{948 - 944}{\sigma}$. Thus, $\sigma = 8$ g/cm^2. There is more variability in the bone densities for older women. This isn't surprising because as women get older there is more time for their good or bad health habits to have an effect, creating a wider range of bone densities.

2.15 (a) Because 22 salaries were less than Lidge's salary, his salary is higher than 22/29 = 76% of his teammates. Thus, his salary is at the 76th percentile.
(b) $z = \frac{6{,}350{,}000 - 3{,}388{,}617}{3{,}767{,}484} = 0.79$. Lidge's salary was 0.79 standard deviations above the mean salary of $3,388,617.

2.16 Madson's salary in 2008 was $1,400,000. Because there were 14 salaries less than Madson's, his salary was higher than 14/29 = 48% of his teammates. Thus, he is at the 48th percentile. Madson's z-score is $z = \frac{1{,}400{,}000 - 3{,}388{,}617}{3{,}767{,}484} = -0.53$. Madson had a typical salary compared to the rest of the team because it was around the 50th percentile (in fact, his salary is equal to the median salary). However, his z-score was negative indicating that his salary was below average. This is because there were a few players who made extremely large salaries.

2.17 To make the standard deviation increase from 3 to 12, multiply each score by 4. This will make the standard deviation equal to 4(3) = 12 and the mean equal to 4(12) = 48. To make the mean increase from 48 to 75, add 27 to each adjusted score. Adding 27 does not change the spread, so the mean will be 48 + 27 = 75 and the standard deviation will still be 12.

2.18 To make the mean change from 68 to 0, Mr. Olsen should subtract 68 from each score. This will make the mean equal to 68 – 68 = 0 and not change the standard deviation. To make the standard deviation change from 15 to 1, divide each adjusted score by 15. This will make the mean equal to 0/15 = 0 and the standard deviation equal to 15/15 = 1. Note that these transformations are equivalent to standardizing each test score.

2.19 (a) The mean and the median both increase by 18 so the mean is 69.188 + 18 = 87.188 inches and the median is 69.5 + 18 = 87.5 inches.
(b) The standard deviation (3.20 inches) and *IQR* (71 – 67.75 = 3.25 inches) do not change because adding a constant to each value in a distribution does not change the spread.

2.20 (a) The mean and median salaries will each increase by $1000 because adding a constant to each value in a distribution increases measures of center by the same amount.
(b) The extremes and quartiles will also each increase by $1000 because adding a constant to each value in a distribution increases all the measures of location by the same amount. The standard deviation will not change because adding a constant to each value in a distribution does not change the spread.

2.21 (a) To give the heights in feet, not inches, we would divide each observation by 12 because there are 12 inches in 1 foot. Thus, mean = 69.188/12 = 5.77 feet and median = 69.5/12 = 5.79 feet.
(b) Standard deviation = 3.2/12 = 0.267 feet and *IQR* = (71 – 67.75)/12 = 0.271 feet.

2.22 (a) The mean and median will each increase by 5% because each value in the distribution is being multiplied by 1.05. Multiplying each value in a distribution by a constant multiplies measures of center by the same amount.
(b) Yes. The *IQR* and standard deviation will both increase by 5% because each value in the distribution is being multiplied by 1.05. Multiplying each value in a distribution by a constant multiplies measures of spread by the same amount.

2.23 To find the mean temperature in degrees Fahrenheit, multiply the mean in Celsius by $\frac{9}{5}$ and add 32. Thus, mean = $\frac{9}{5}(25)+32=77$ degrees Fahrenheit. To find the standard deviation, we just multiply by $\frac{9}{5}$ since adding 32 just shifts the distribution and does not affect the spread. Thus, standard deviation = $\frac{9}{5}(2)=3.6$ degrees Fahrenheit.

2.24 To get a correct measurement in inches we need to subtract the 0.2 inches that Clarence mistakenly added to each value. Then to transform that same measurement to cm we need to multiply by 2.54. So the new mean is $(3.2-0.2)(2.54)=7.62$ cm. Subtracting a constant from each value in a distribution does not affect the standard deviation, so we just multiply the old standard deviation by 2.54. The new standard deviation is $0.1(2.54)=0.254$ cm.

2.25 c

2.26 a

2.27 c

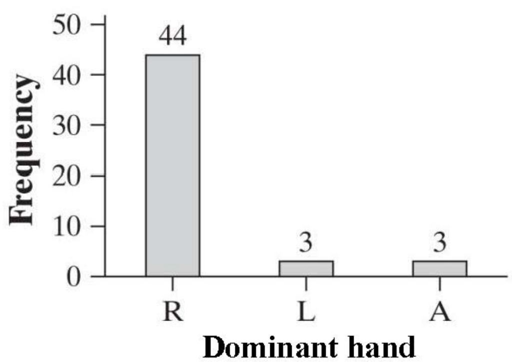
2.28 b

2.29 c

2.30 d

2.31 The distribution is skewed to the right because most of the values are 30 minutes or less, but the values stretch out up to about 90 minutes. The data is centered roughly around 20 minutes and the range of the distribution is close to 90 minutes. The two largest values appear to be outliers.

2.32 (a) A bar graph is given below:



(b) Because 3/50 = 6% of the sample was left-handed, our best estimate of the percentage of the population that is left-handed is 6%.